

# HCaI LED Calibration

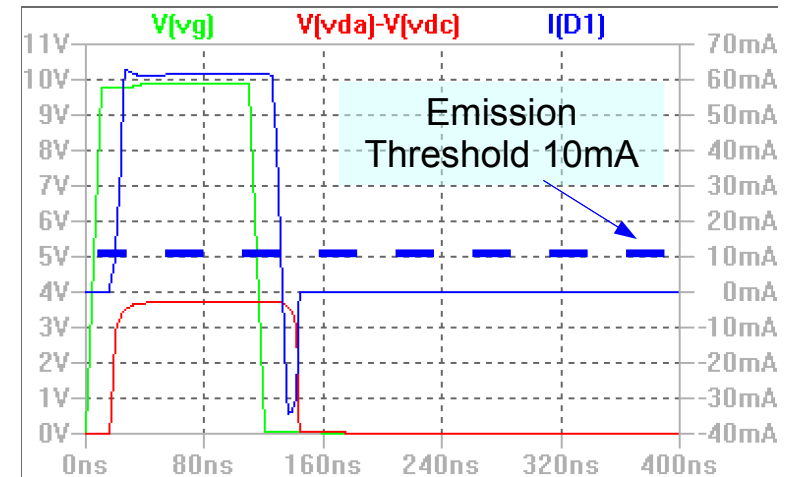
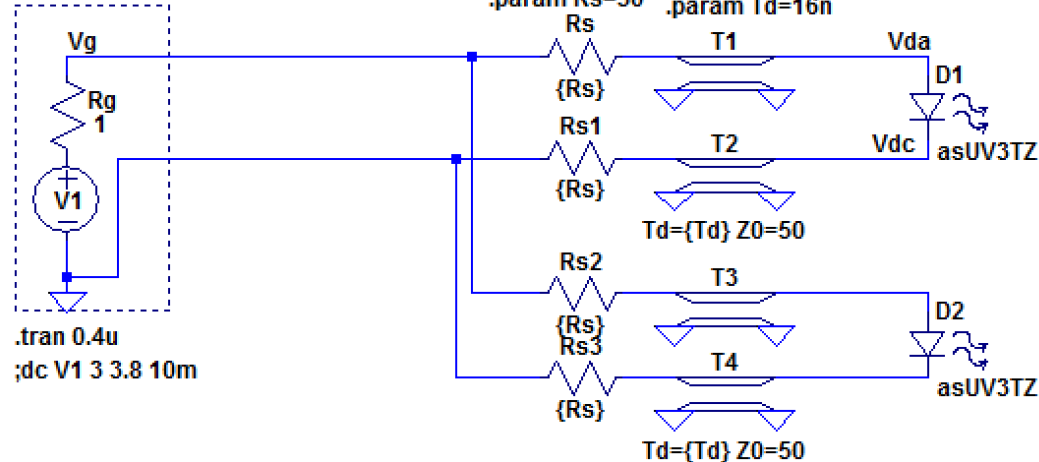
# Driving multiple LEDs with long (8ns) leads

```
.MODEL asUV3TZ D (IS=93.2P RS=42M N=7.1 BV=15 IBV=10U CJO=2.97P
+VJ=.75 M=.333 TT={TT} lave=40m Vpk=5 type=LED)
```

```
.param TT 10n
```

```
PULSE(0 10 0 10n 10n 100n)
```

Generator



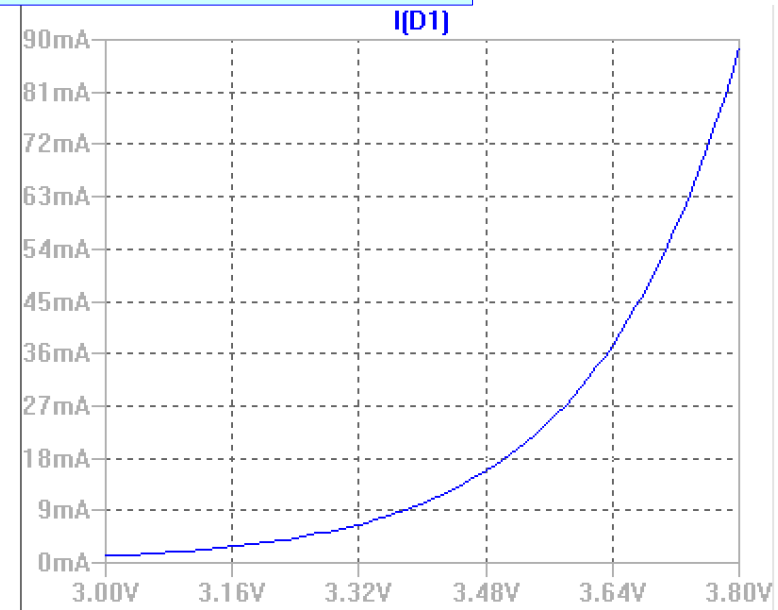
- Low impedance generator.
- Source termination.

# IV curve of the spice model of UV3TZ LED

Defines the forward threshold voltage

```
.MODEL asUV3TZ D (IS=93.2P RS=42M N=7.1 BV=15 IBV=10U CJO=2.97P
+VJ=.75 M=.333 TT={TT} lave=40m Vpk=5 type=LED)
.param TT 0.1u
```

Transit time, not known



From the data sheets

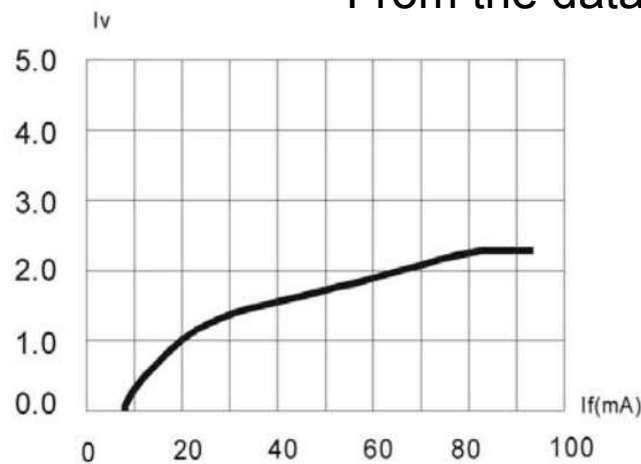


Fig.2 Relative Luminous Intensity vs. Forward Current

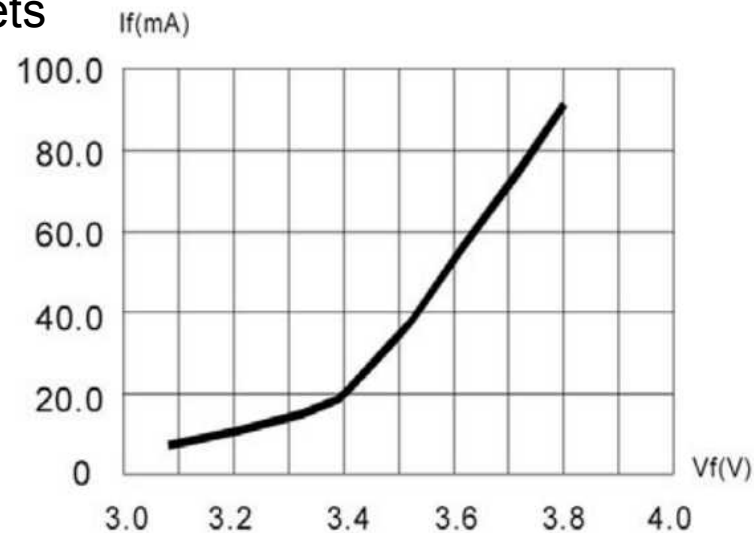
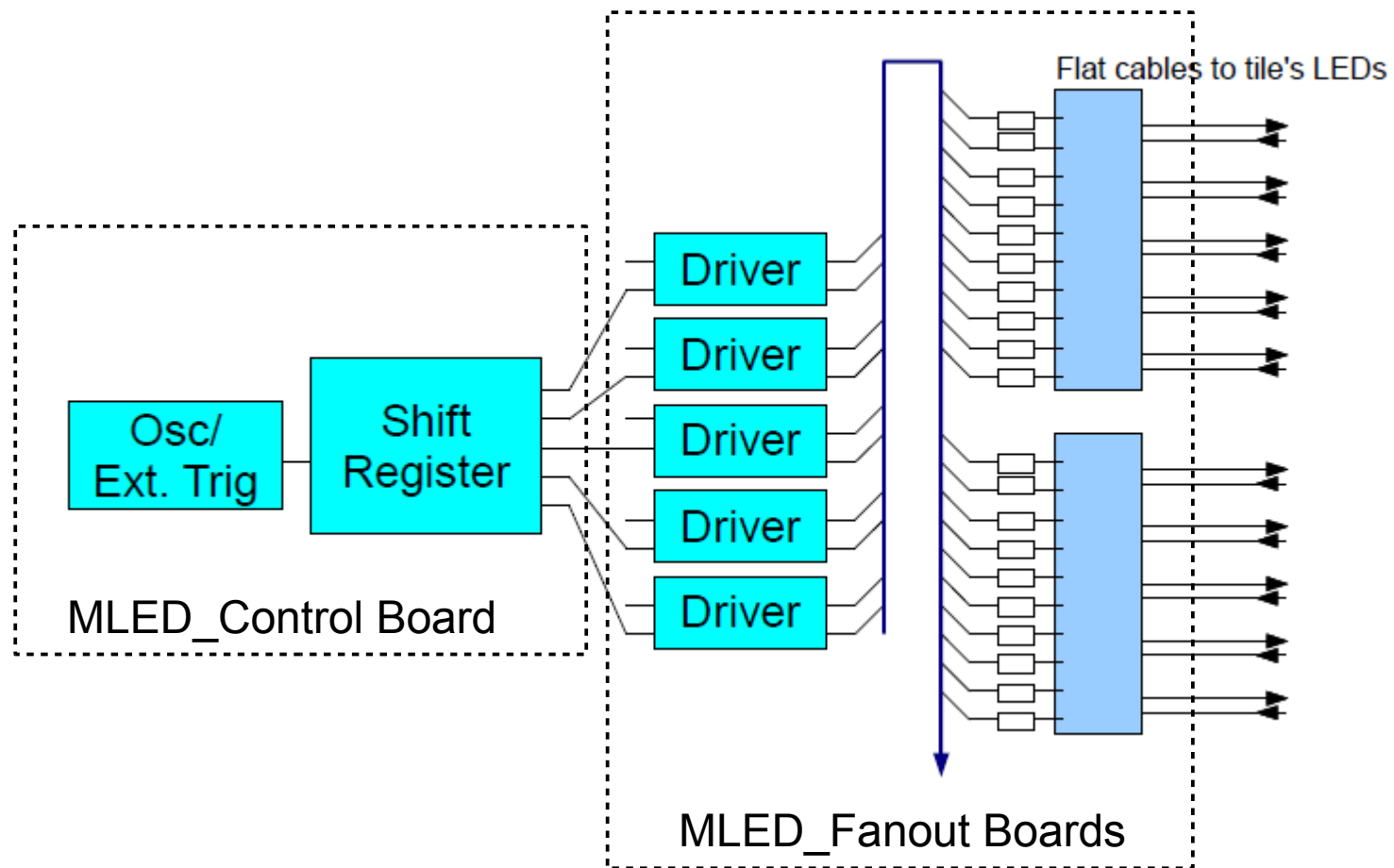


Fig.1 Forward Current vs. Forward Voltage

# Functional Diagram



# Cables



3M™ Round, Shielded/Jacketed, Flat Cable

.050" 28 AWG Stranded, Mass Terminatable, PVC/PVC 3659 Series

Characteristic Impedance:

Unbalanced, Balanced: 62  $\Omega$ , 106  $\Omega$

Capacitance: 27.7 pF/ft [ 90.88 pF/m ] 15.2 pF/ft [ 49.9 pF/m ]

Inductance: 0.11  $\mu$ H/ft [ 0.35  $\mu$ H/m ] 0.17  $\mu$ H/ft [ 0.57  $\mu$ d/m ]

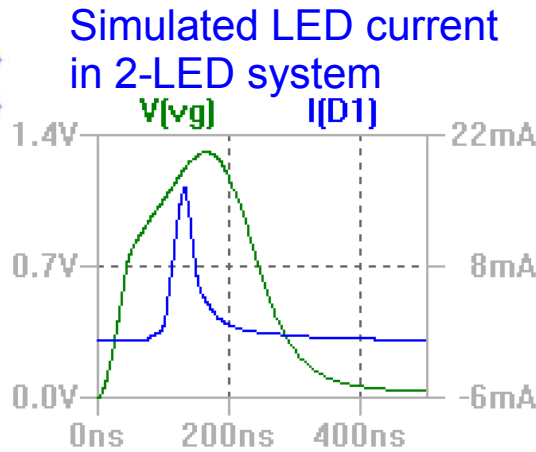
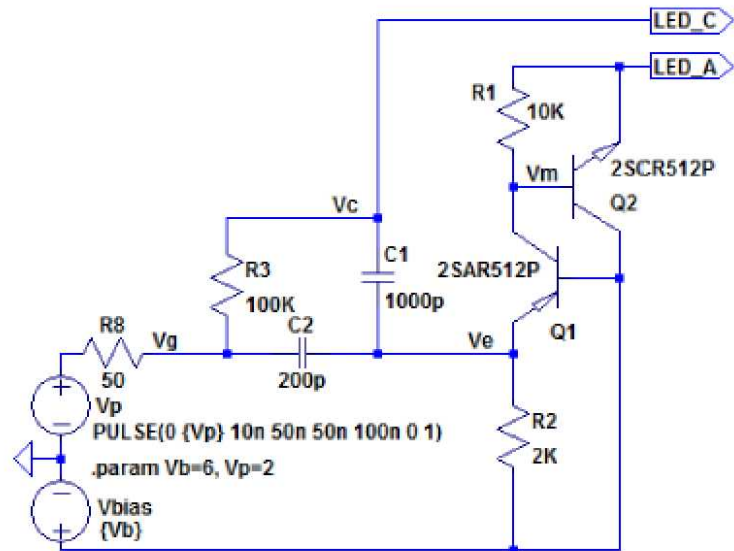
Propagation Delay: 1.72 ns/ft [ 5.64 ns/m ] 1.62 ns/ft [ 5.31 ns/m ]

Outer diameter: 7.0mm (10 lines), 8.0mm (15 lines)



Cable shield is grounded on the tile side.  
No ground lines from the driver.

# Driver



J. Kapustinsky design (1985).  
 Mods:  
 Powerful transistors,  
 Large discharge capacitor C1.

Inputs: Vbias, 6V – 30V  
 Trigger: Vp, positive front >1.5V

Outputs:

**Rise time:** Resistive load: ns, fall time 7ns (defined by C1).

Rise/fall time on multiple LEDs with 8ns leads: 20ns.

**Current amplitude on zero load:** 2A at Vbias=6V.

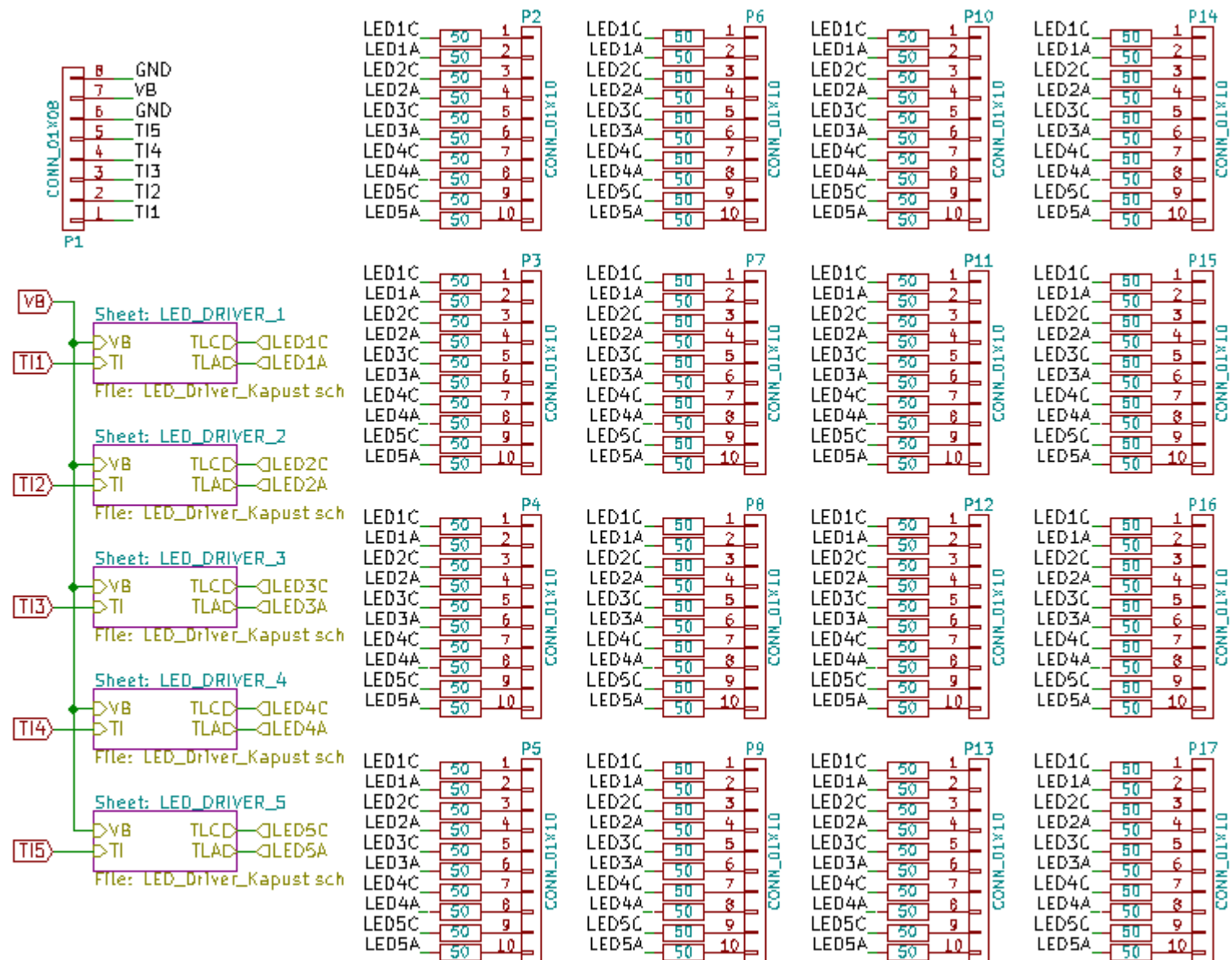
Amplitude proportional to the Vbias.

The LED lines are very weakly bound to the ground,  
 expect minimal ground interference.

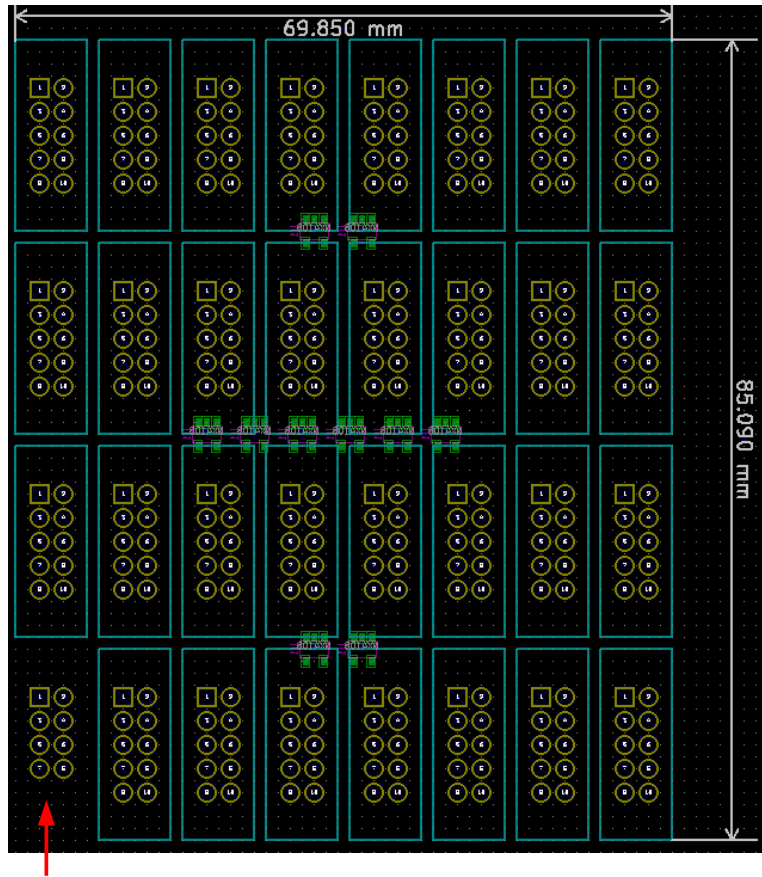
Can drive up to 100 LEDs through 100 ohm differential lines.

Very low power consumption: 10  $\mu$ A at 1 KHz on 50 LEDs

# Schematics of the MLED\_Fanout



# Layout Scetch of the MLED\_Fanout Board

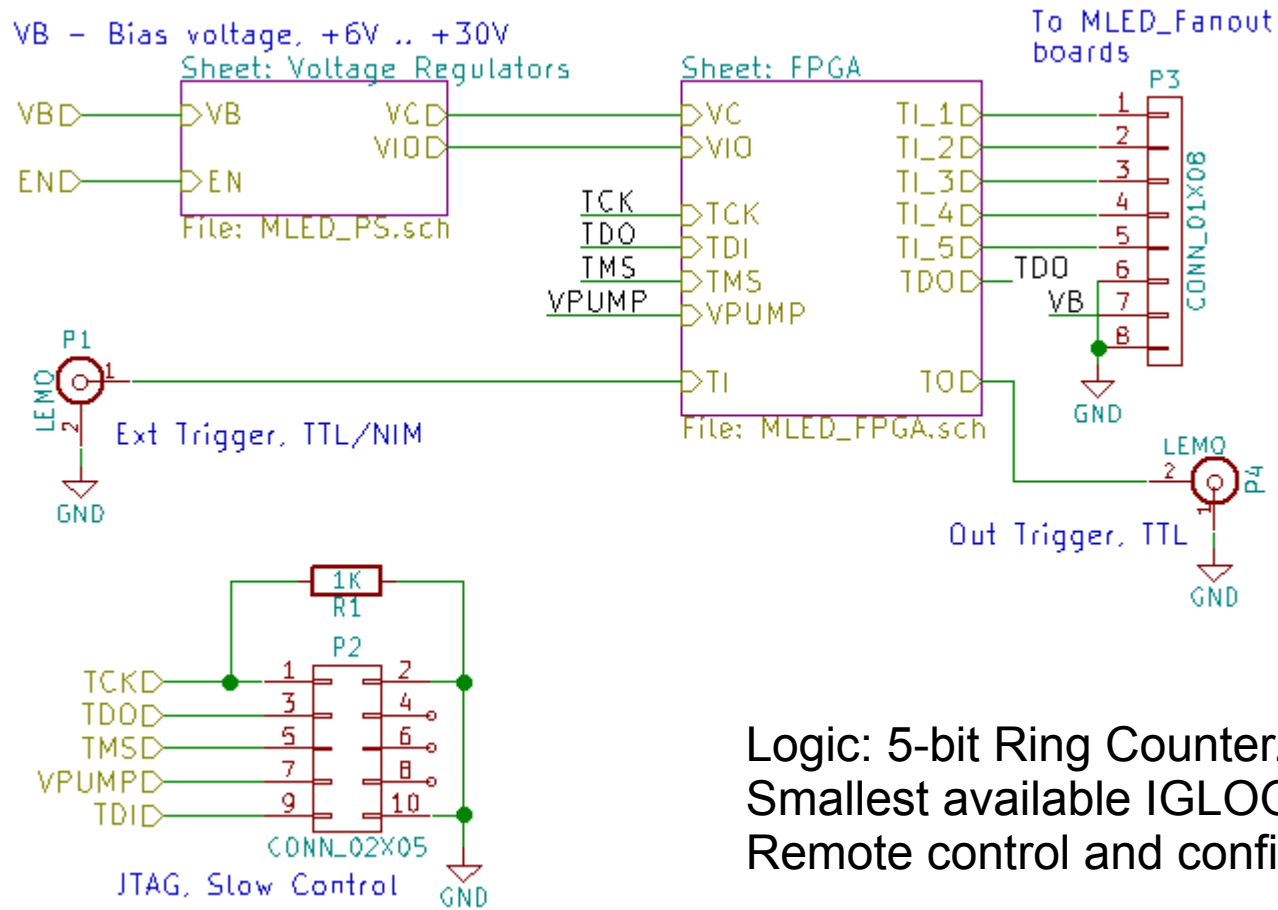


For 15 HCAL modules.

Cable to MLED\_Control



# Schematics of the MLED\_Control



Logic: 5-bit Ring Counter.  
Smallest available IGLOO-Nano FPGA  
Remote control and configuration.